CHAPTER 3

DISPOSAL

3-1. General

Once the treatment process has been carried out to the degree necessary, disposal of the effluent must be performed. There are three basic methods of disposing of the effluent; dilution, evaporation or irrigation.

3-2. Dilution

Dilution is simply the process of adding liquid waste (s) to a body of water. This is, at the present time, the most common method of disposal. However, the sewage which is discharged into lakes or rivers can be stabilized in much the same way that natural sewage treatment occurs in a sewage lagoon. Oxygen is required for this natural stabilization and only a limited quantity of oxygen can be dissolved in any body of water. Lakes and rivers are thus limited in the load of sewage which they may accept without rising to an objectionable level of pollution. A point is reached at which the stream, river or lake is unable to clean itself as fast as pollutants are added. Therefore, if feasible, sewage should be treated prior to dilution.

a. Problems. Even when dealing with treated effluent, disposal by dilution presents basic problems. Great care must be exercised so that the effluent mixture is not a nuisance to the installations adjoining the disposal areas. Water supplies may be contaminated and polluted. Dilution should occur downstream from a water point or installation to prevent those conditions. The less treated the effluent, the more acute the problems become and the more care must be exercised in disposal. Stream flow required for disposal by dilution depends on the strength and quantity of the sewage, the density and nearness of population to stream bank, and” the industrial or domestic use of the stream water below the outfall. A stream overloaded with sewage develops sludge banks and surface scum, is unsightly, and emits an offensive odor. Table 3-1 provides a guide for determining the quantity of sewage that may be discharged into a stream, provided the stream water below the sewage outfall is not for industrial or domestic water supply. Military standards for dilution and sanitary conditions are the same as those used in civilian practice. If military expediency forces substandard sanitary conditions, they must be corrected as rapidly as possible.

b. Procedure. Effluent may be diluted in any body of water; e.g. oceans, lakes, rivers and streams. In general, the procedures for disposal in each of these areas are the same. Discharge points should be as far from the shore as possible. In addition, they should be deep in the water. Meeting these two criteria will allow the sewage to dilute thoroughly before it has the opportunity to rise to the surface. Careful consideration must be made of current directions and strengths in picking the discharge points. In a river or stream the outfall should be in the swift current, not in the slack-water close to shore where little diluting will e place. In ocean waters tide or wind currents, if not considered, may wash the effluents back toward the shore. Where currents vary with the season of the year, care must be taken in placing discharge points.

3-3 Evaporation

Evaporation is sometimes used in sewage disposal. In this process, large surface areas of sewage are exposed to the atmosphere. Since the effluent is 99.8% water, it evaporates easily; but the process is hindered by climatic conditions like rain and cold, and works best in arid climates. Evaporation usually occurs to a certain degree in lagoons and oxidation ponds. Evaporation is not and should not be considered as a primary means of disposal.

3-4. Irrigation

The third method of disposing of the effluent is by irrigation, that is, the spreading of the polluted water onto or through soil. As in dilution, irrigation allows some purification although this is not its primary function. The process is performed in either of two methods; surface irrigation (sewage farming), or subsurface irrigation.

a. Regardless of the type of irrigation involved, the absorptive ability of the soil must be determined before designing or constructing the disposal facility. This property is usually determined by conducting a general-purpose percolation test as follows:

(1) Dig one or more hole(s) 1 foot square and 1 foot deep.

(2) Fill the test hole(s) with water and allow it to soak into the surrounding soil.

(3) After the water has seeped into the soil and the bottom of the hole is still wet, pour water into the hole (s) to a depth of at least 6 inches.

(4) Measure the depth of water and record the time required for all of it to seep out into the surrounding soil.

(5) Calculate the average time required for the water to drop 1 inch by dividing the initial depth of water in the hole by the number of minutes it took for all of the water to seep out. The surface area required for a given volume of sewage per day can be determined by applying this value to the appropriate chart (tables 3–2 through 3-5).

b. Besides the fact that there are different absorption rate charts for surface irrigation, tile drainfields, sewage lagoons, and cesspools, the following test hole conditions should be met:

(1) For tile drainfields, the bottom of the 1 foot square test hole should roughly coincide with the proposed depth of tile.

(2) For cesspools, the 1 foot square test hole should be dug roughly half way between the sewage inlet and the bottom of the proposed cesspool.

(3) For sewage lagoons, the top of the 1 foot square test hole should roughly coincide with the proposed bottom of the lagoon.

(4) Tables to indicate approximate absorption rates for cesspools, tile drain fields, sewage lagoons, and surface irrigation are as listed below in tables 3-2 through 3–5.

Table 3–1. Dilution Rates

Minimum stream flow required for dilution of raw and treated sewage *

Type of treatment	Dilution per 1,000 sewage-contributing population	
	Densely populated areas	Sparsely populated areas
None	20 cfs and over	5 cfs and over
Partial (settling)	12 to 20 cfs	3 to 5 cfs
Complete	6 to 12 cfs	0 to 3 cfs

* Oxidation ponds or irrigation with disposal to ground water can be used if enough water for dilution is not available.

Table 3–2. Application Rates of Sewage in Cesspools

Time (in minutes) required for water level to drop 1 inch in test hole.	*Allowable rate of sewage application in gallons per square foot of percolating area per day.*
1	5.3
2	4.3
5	3.2
10	2.3
30	1.1

Note. Soils requiring more than 30 minutes for a fall of 1 inch are unsatisfactory for the installation of cesspools and some other disposal method should be used.

Table 3–3. Subsurface Application Rates of Sewage in Tile Drainfields

Time (in minutes) required for water level to drop 1 inch in test hole.	*Allowable rate of sewage application in gallons per square foot of trench bottom per day.*
1	4.0
2	3.2
5	2.4
10	1.7
30	0.8
60	0.6

Table 3–4. Relative Absorption Rates in Sewage Lagoons

Even though the information listed below is applicable to the same percolation tests as the information in tables 3–2, 3–3, and 3–5, there is an entirely different purpose for conducting the test for lagoons In the cases of cesspools, tile drainfields, and surface irrigation, it is desirable to have a high absorption rate so that the effluent can be disposed of easily. However, absorption from sewage lagoons into the surrounding soil is a problem and should be minimized.

Time (in minutes) required for water level to drop one inch in test hole.	*Relative absorption rate.*	*Classification of the type of soil.*
0–3	Rapid	Coarse sand or gravel
3–5	Medium	Fine sand or sandy loam.
5–30	Slow	Clay, loam or clay with sand.
30–60	Semi-impervious	Dense clay
60 and over	Impervious	Hardpan or rock

Note. The first two types of soil are not suited for lagoon purposes unless water retention is assisted by the installation of a waterproofing skin at the lagoon bottom.

c. Surface irrigation is spreading effluent over plowed fields, allowing the liquid to filter through the ground until it reaches the water table. Disposal rates of sewage by surface irrigation vary with the permeability of the soil, ranging as high as 60,000 gallons per acre per day. This method can assist in the purification of sewage through filtration and aeration. However, to support the purification process, sufficient air must always be in the soil. Therefore, only intermittent irrigation of the soil is possible to permit the soil to "breathe" after each application. This "breathing" restores the oxygen content of the soil and helps maintain aerobic conditions. In addition to intermittent spreading, ground used for surface irrigation must be rested. With use, the surface will clog and must be scraped off. Allowances for resting, recovery, maintenance, and rainfall are included in table 3-5.

Table 3-5. Application Rates of Sewage in Surface Irrigation

Time (in minutes) required for water to fall one inch in test hole.	Allowable rate of sewage application per day.	
	Per acre	Per sq ft
1	57,700	1.3
2	46,800	1.1
5	34,800	0.8
10	25,000	0.6
30	12,000	0.3
60	8,700	0.2

Figures are approximate and are suggested for use as a guide only.

d. Subsurface irrigation is a method of sewage disposal commonly used in conjunction with cesspools or septic tanks at small installations. This method allows sewage to seep directly into the soil or uses tile drainfields with application rates as shown in tables 3-2 and 3-3, respectively.

(1) *Tile drain fields.* The tile drainfield essentially consists of lines of concrete or clay form draintile laid in the ground with open joints. Recently, manufactures have begun to produce concrete pipe with ¼" to 3/8" perforations in the bottom half. Also, a bituminized fiber pipe (Orangeburg Alkacid) with holes bored in the lower portion of the pipe to allow drainage may be used for these drain lines. This pipe is light, easily laid in the trench, and made in sizes between 2 and 8 inches in diameter and 5 and 8 feet in length. These long lengths make it particularly valuable in soil where other types may settle unevenly. Perforated plastic pipe offers the same advantages. Figure 3-1 shows a typical field layout. The following conditions are important for proper functioning of tile fields:

(a) Ground water well below the level of the tile field.

(b) Soil satisfactory leaching characteristics within a few feet of the surface, extending several feet below the tile. Soil leaching tests should be made at the site.

(c) Subsurface drainage away from the field.

(d) Adequate area.

(e) Freedom from possibility of polluting drinking-water supplies, particularly from shallow dug or driven wells in the vicinity.

(f) Length of tile and details of the filter trench generally depend upon the character of the soil.

(g) Minimum widths of trenches on the basis of soils areas follows:

1. Sand and sandy loam, 1 foot.

2. Loam and sand and clay mixture, 2 feet.

3. Clay with some gravel, 3 feet.

(h) Placing tile below the frost line to prevent freezing is not necessary. Tile placed 18 inches below the ground surface operated successfully in New England for many years. Subsurface tile should never be laid below ground-water level.

(i) Design and construction should provide for handling and storage of some solid material, eliminating as much as practicable the opportunity for clogging near pipe joints. Pipe 3 to 6 inches in diameter is recommended. The larger pipe gives greater storage capacity for solids and a larger area at the joint for solids to escape into the surrounding gravel.

(j) To provide for free discharge of solids from the line to the filter trench, the pipe must be laid with 3/8-inch-clear openings. The top of the space is covered with tarpaper or similar material to prevent entry of gravel. Bell and spigot pipe is easily laid to true line and grade. Good practice calls for breaking away two-thirds along the bottom of the bells at the joint and using small wood-block spacers. The pipe is commonly laid at a slope of about 0.5 feet per 100 feet when taking the discharge directly from the septic tank and 0.3 feet per 100 feet when a dosing tank is used ahead of the field.

(k) The tile is laid on a bed of screened coarse gravel 6 inches deep with 3 inches of coarse gravel around and over the pipe. Coarse screened stone passing a 2 1/2-inch mesh and retained on a 3/4-inch mesh is recommended. This gravel bed gives a relatively large percentage of voids into which the solids may pass and collect before the effective leaching area becomes seriously clogged. The soil which fills the trench must not fill the voids in the coarse screened gravel around the pipe. A 3-inch layer of medium screened gravel over the coarse stone and 3 inches of either fine screened gravel or suitable bank-run gravel over the medium stone is recommended.

(l) The layout of the tile in the field should be carefully designed. Generally, the length of laterals should not be greater than 75 feet. When tile is laid in sloping ground, the flow must be distributed so each lateral gets a fair portion. Flow

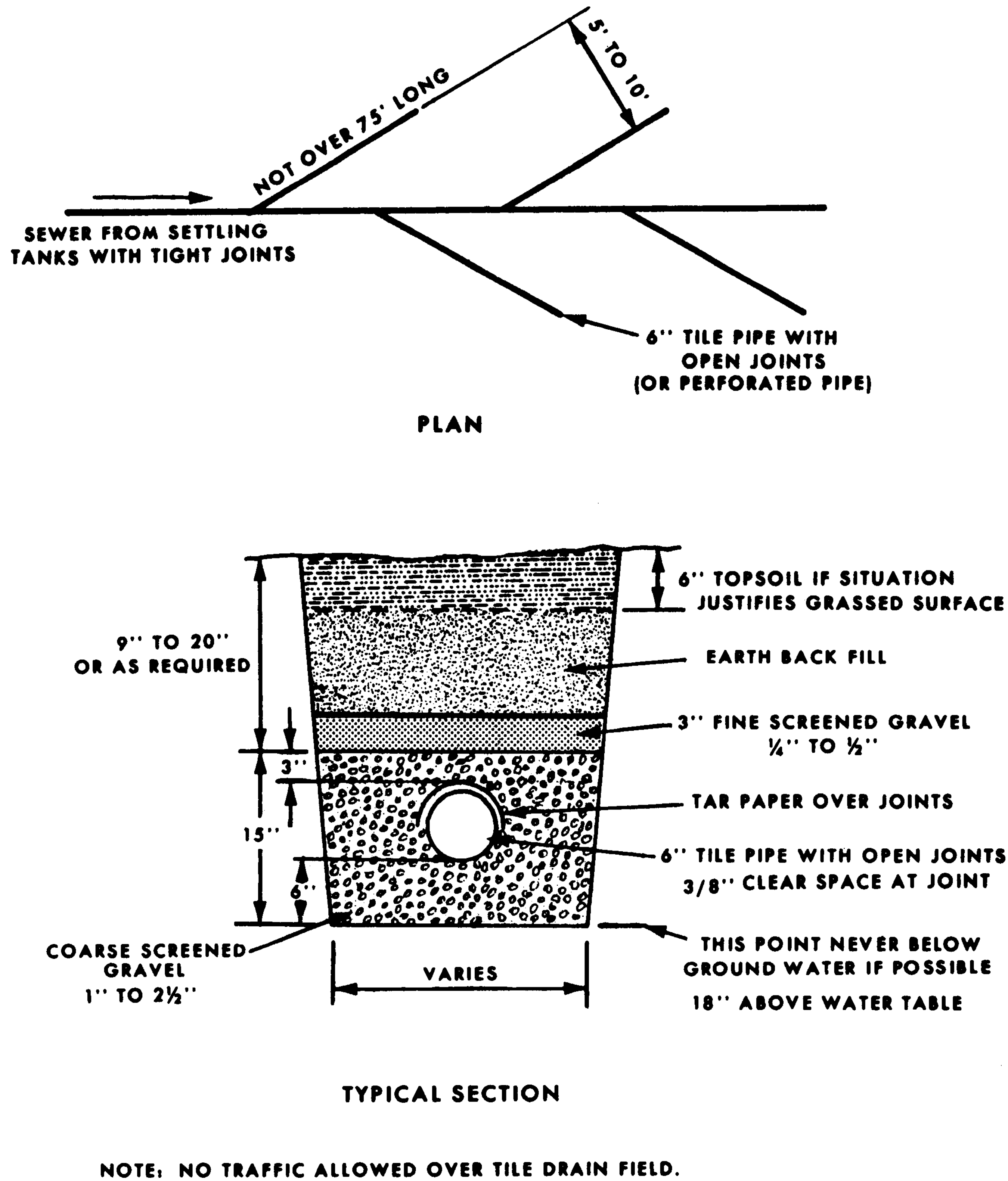

Figure 3–1. Typical layout of a subsurface tile system.

must be prevented from discharging down the slope to the lowest point. Individual lines should be laid parallel to land contours (fig 2-2). Tile fields are commonly laid out either in a herring-bone pattern or with the laterals at right angles to the main distributor. Distance between laterals

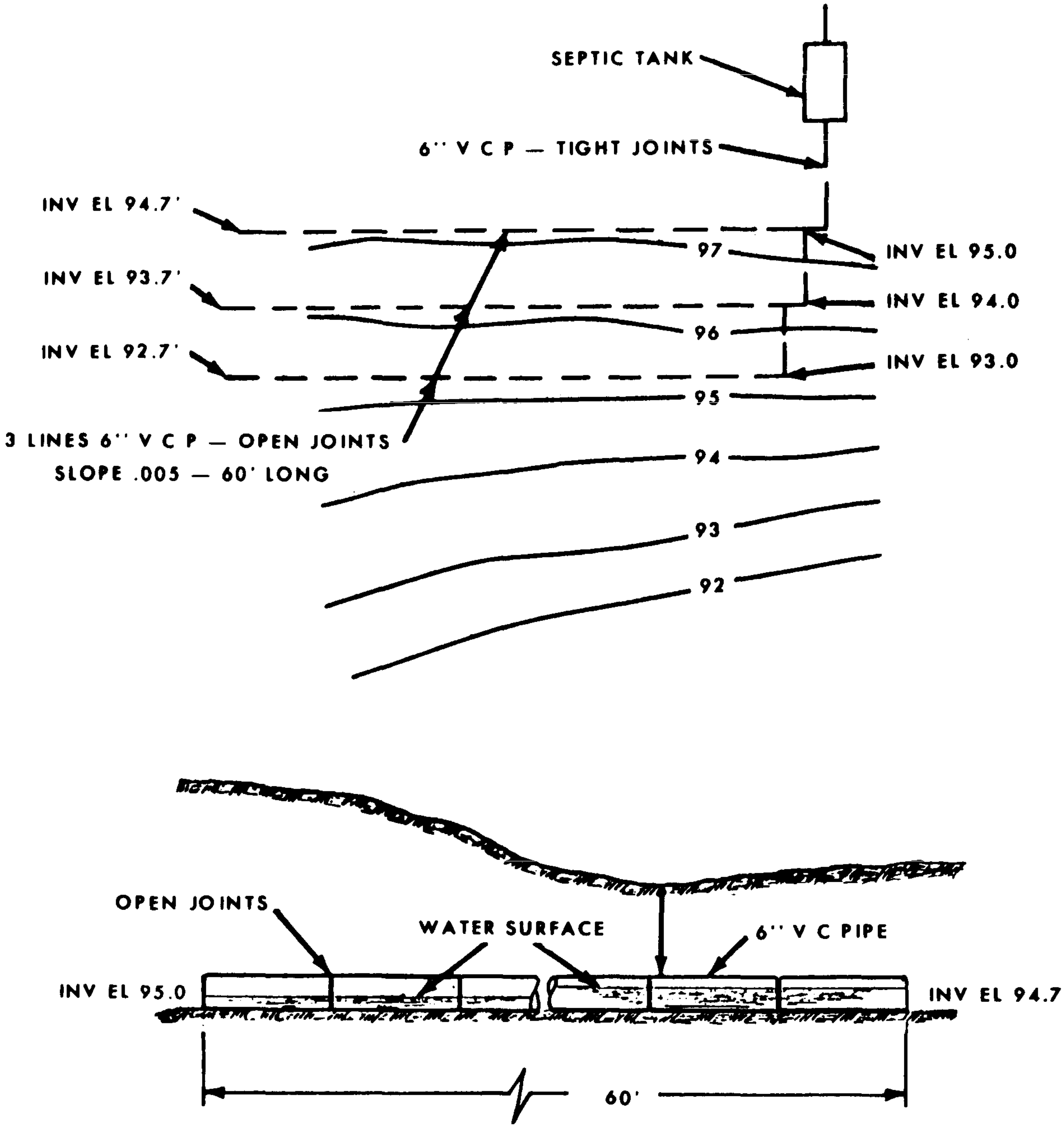

Figure 3-2. Typical layout of tile field in sloping ground.

is 3 times the width of the trench. Distribution boxes to which the laterals are connected may be desirable. Trenches 24 inches wide or more are economical. If a trenching machine is practical on a large installation, the design should be based on the width of trench excavated by the machine.

(m) Once a tile field is constructed, all traffic must be excluded by fencing or posting to prevent crushing the tile. Planting shrubs or trees over the field is not good practice since the roots tend to clog the tile lines; grass over the lines assists in removing the moisture and keeping the soil open. A typical section of a tile filter trench is shown in figure 3-1.

(2) *Subsurface drain field.* Where the soil is so dense and impervious that a subsurface tile-trench system is impractical and where lack of an isolated area prevents use of an open filter, subsurface filter trenches or beds may be required. Underdrains from subsurface filter trenches or beds may be discharged freely to the nearest satisfactory point of disposal such as a small stream, dry stream bed, or on land.

(a) The filter trenches or beds should be designed for a rate of filtration not greater than 1 gallon per square foot per day. The filtering material should be clean, coarse sand all passing a 1/4-inch mesh with an effective size between 0.25 and 9.5 millimeters and a uniformity coefficient not greater than 4.0. Filtering sand should generally be not less than 30 inches deep. Coarse screened gravel should pass a 3 l/2-inch mesh and be retained on a 3/4-inch mesh. A typical section of an underdrained filter trench is shown in figure 3-3. Governing conditions for the field layout are similar to those for the tile fields described above.

(b) A typical plan and section for a subsurface filter bed are shown in figure 3-4. Slope of the distributors should be about 0.3 feet per 100 feet when a dosing tank is used or 0.5 feet per 100 feet when no dosing tank is required. For installations having more than 800 feet of distributors, the filter should be built in two or more sections with alternating siphons to alternate the flow between sections. Distribution pipe lines in beds should be laid on 6-to 10-foot centers; underdrain pipes on 5-to 10-foot centers.

(c) Dosing tanks with automatic sewage siphons should be provided for tile or subsurface fields when the length of distribution tile exceeds 300 feet. Dosing tanks should be designed to discharge a volume equal to 70 to 80 percent of the volumetric capacity of the distribution piping in the tile field or filter. The dosing tank can usually be constructed in the same width and as a part of the septic tank (fig 3-5).

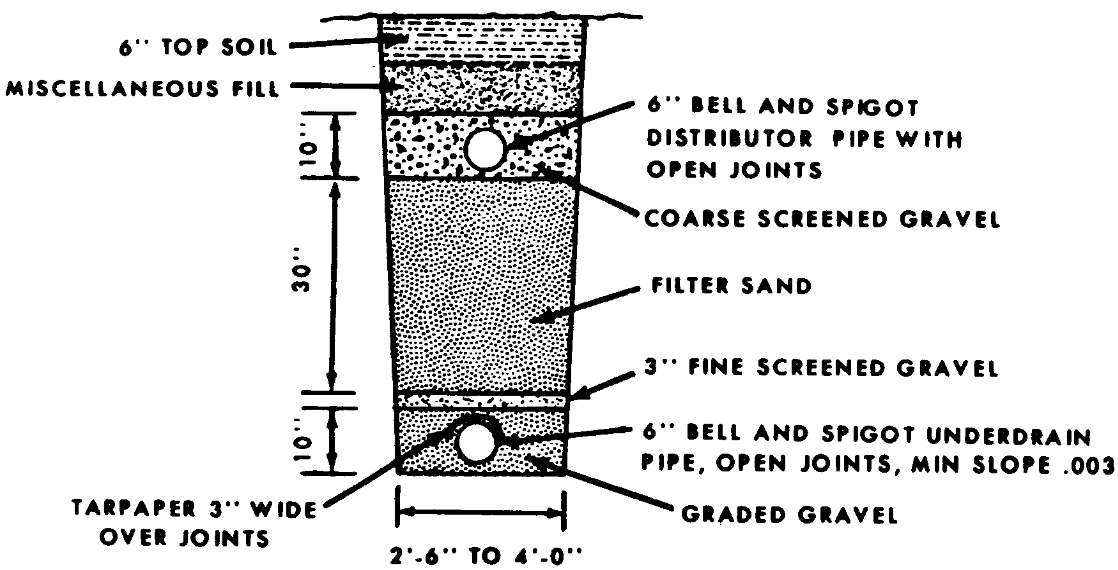

Figure 3-3. Typical section of underdrained filter trench.

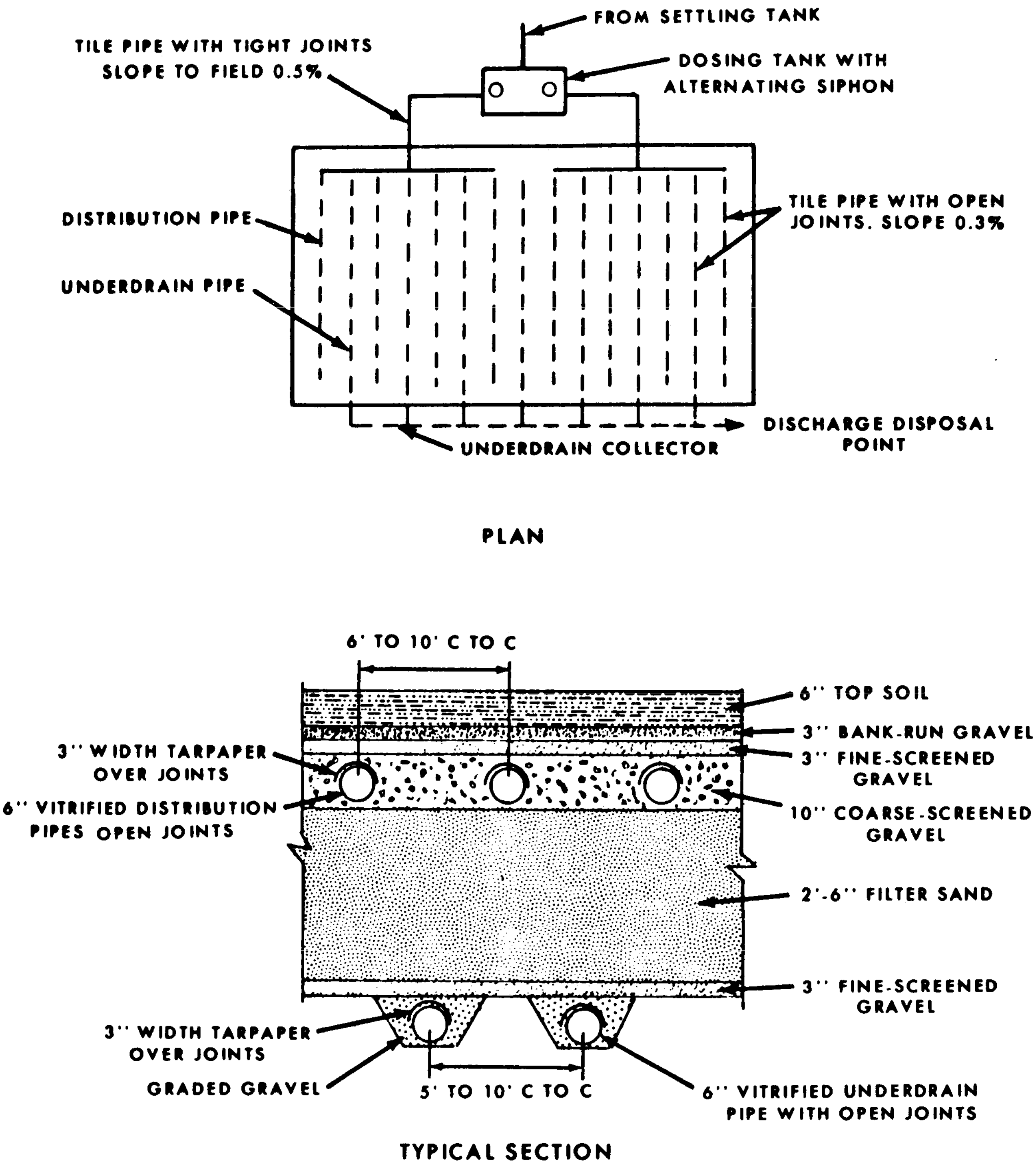

Figure 3-4. Typical plan and section of subsurface sand filter.

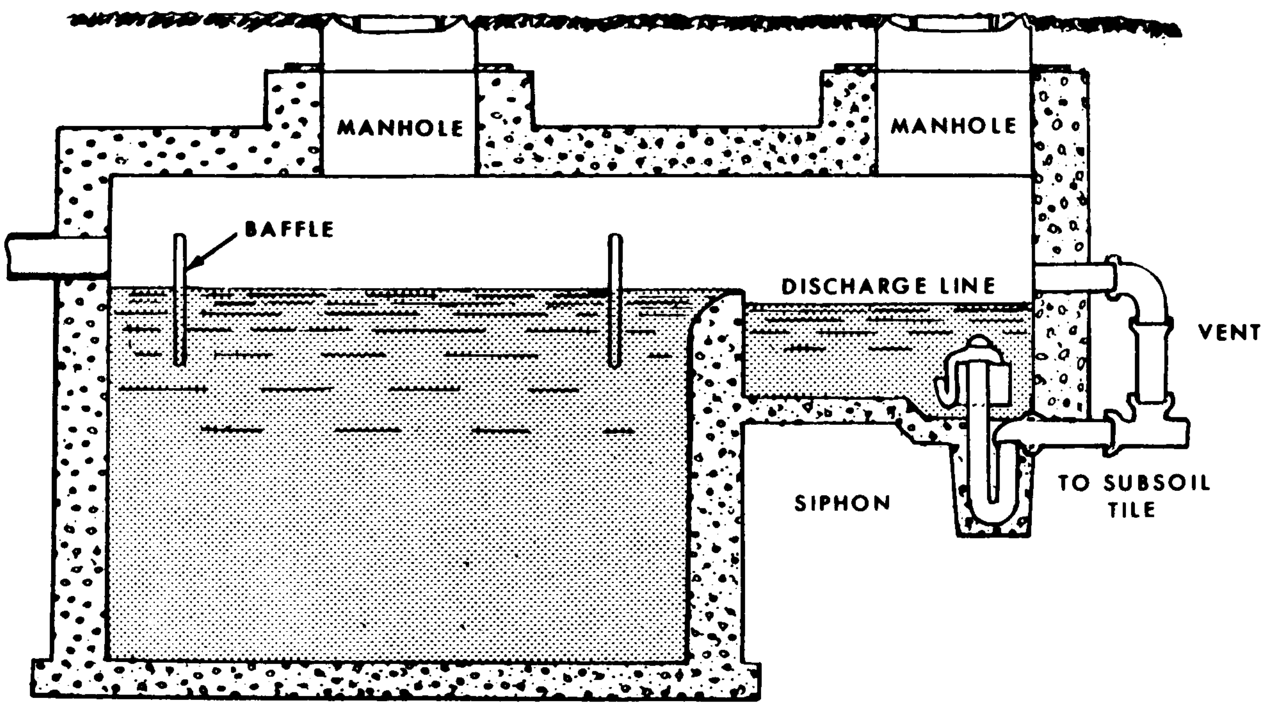

Figure 3–5. Septic tank with dosing siphon.